BLM LIBRARY
88070434

T/N 274
Filing Code 6763

Date Issued AUGUST 1975

Anderson and Miyajima. 1975.

05673 CFF

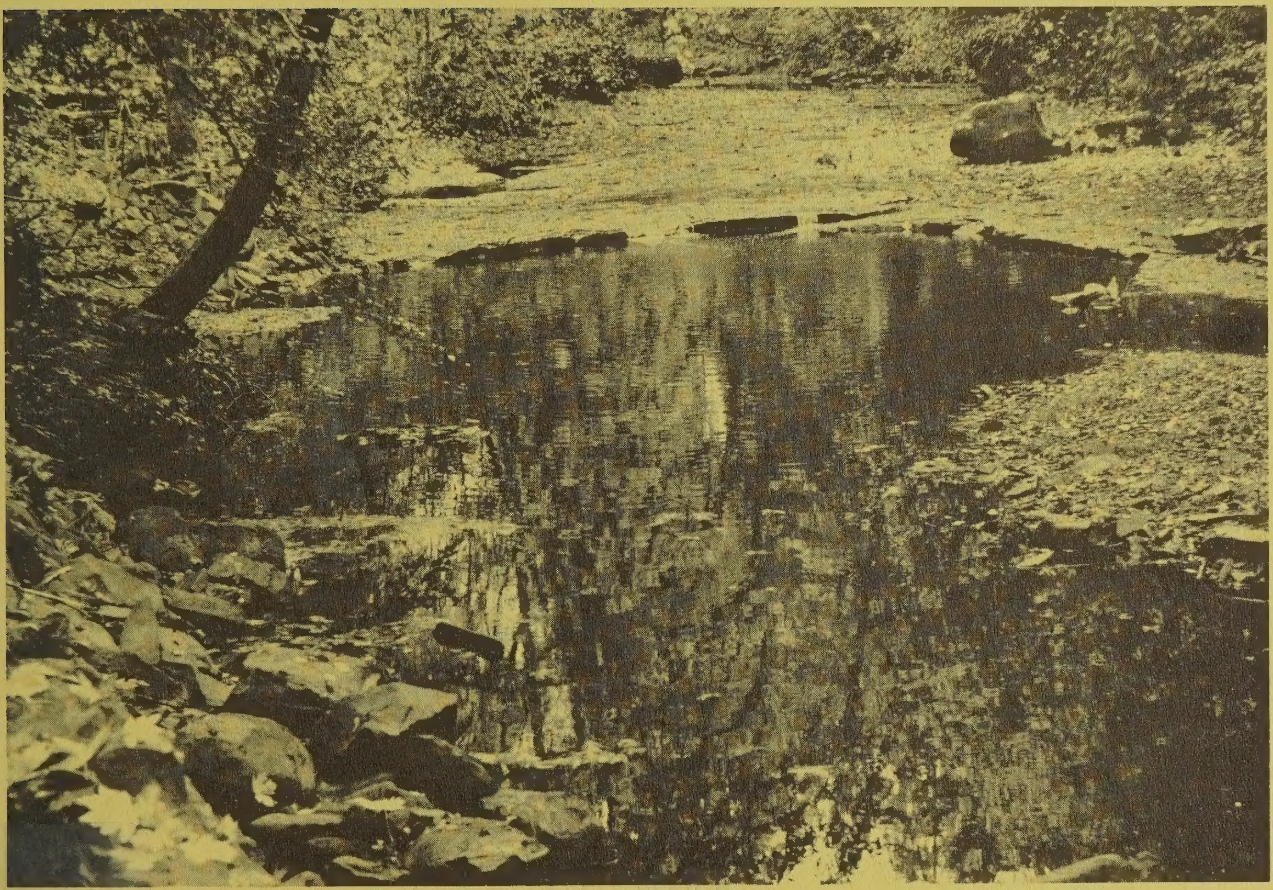
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

TECHNICAL NOTE

U.S. DEPARTMENT OF THE INTERIOR – BUREAU OF LAND MANAGEMENT

ANALYSIS
of the
VINCENT CREEK FISH REARING POOL PROJECT

by
John W. Anderson and Lester Miyajima
Coos Bay District
Oregon



QL
84.2
.L35
no.274

dditional copies of Technical Notes are available from DSC, Federal Center Building 50, Denver, Colo., 80225

RECEIVED
BUR OF LAND MGMT
SEP 8 8 14 AM '75
CALIF. STATE OFFICE
SACRAMENTO, CALIF.

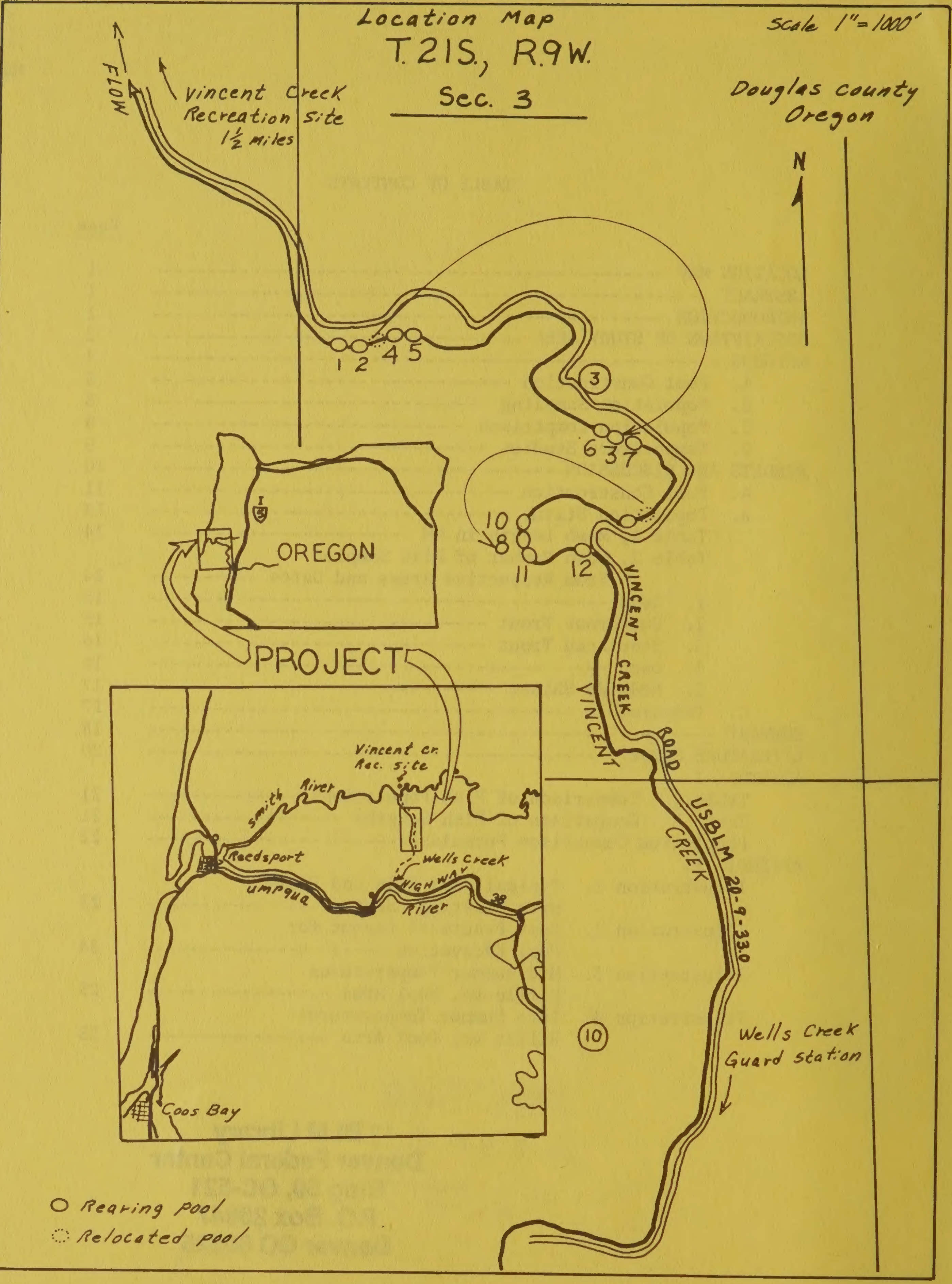
#4242431
ID: 88070434
QL
84.2
.L35
no.274

TABLE OF CONTENTS

Page

LOCATION MAP -- i
ABSTRACT -- 1
INTRODUCTION -- 1
DESCRIPTION OF STUDY AREA --------------------------------- 2
METHODS --- 4
  A. Pool Construction ------------------------------------ 5
  B. Population Sampling ---------------------------------- 8
  C. Population Comparison -------------------------------- 9
  D. Temperature Studies ---------------------------------- 9
RESULTS AND DISCUSSION------------------------------------- 10
  A. Pool Construction ------------------------------------ 11
  B. Population Status ------------------------------------ 13
    Table 1, Mean Length in MM ---------------------------- 14
    Table 2, Mean Number of Fish Sampled
      From Respective Areas and Dates --------------------- 14
    1. Coho --- 15
    2. Cutthroat Trout ------------------------------------ 15
    3. Steelhead Trout ------------------------------------ 16
    4. Dace --- 16
    5. Redside Shiner ------------------------------------- 17
  C. Temperature -- 17
SUMMARY --- 18
LITERATURE CITED -- 20
APPENDIX I
  Table 1 Comparison of Fish Populations ------------------ 21
  Table 2 Comparison of Fish Lengths ---------------------- 21
  Population Comparison Formulas--------------------------- 22
APPENDIX II
  Illustration 1. Typical Pool Plan and Profile
    with Blasting Layout ---------------------------------- 23
  Illustration 2. Best Practical Layout for
    Pool Excavation --------------------------------------- 24
  Illustration 3. Mid-summer Temperatures
    Riffle vs. Pool Area ---------------------------------- 25
  Illustration 4. Late Summer Temperatures
    Riffle vs. Pool Area ---------------------------------- 25

BLM Library
Denver Federal Center
Bldg 50, OC-521
P.O. Box 25047
Denver CO 80225


Location Map
T.21S., R.9W.
Sec. 3
Scale 1" = 1000'
Douglas county
Oregon
N
FLOW
Vincent Creek
Recreation site
1½ miles
1
2
4
5
3
6
3
7
10
8
11
12
VINCENT CREEK ROAD
VINCENT CREEK
USBLM 20-9-33.0
Wells Creek
Guard station
10
OREGON
PROJECT
Vincent cr.
Rec. site
Smith River
Reedsport
Wells Creek
HIGHWAY
38
Umpqua
River
Coos Bay
○ Rearing pool
◌ Relocated pool

ABSTRACT

The Vincent Creek basin of Smith River, Oregon, was selected for an experimental stream habitat improvement project following the devastating Oxbow Fire of 1966. The project included a new technique for creating rearing areas by blasting and excavating pools in a solid rock stream channel. Eleven of the twelve pools retained satisfactory water depth following winter freshets which demonstrates they are capable of self-cleaning and low maintenance. Thermograph readings that compared water temperatures in riffles and pools showed a more favorable environment in the pools. The diurnal temperature fluctuations were shorter in duration and several degrees Farenheit lower in the pools than on the riffles. A comparison of fish populations before and after pool construction indicates a significant increase of juvenile coho salmon due to improvement of habitat.

INTRODUCTION

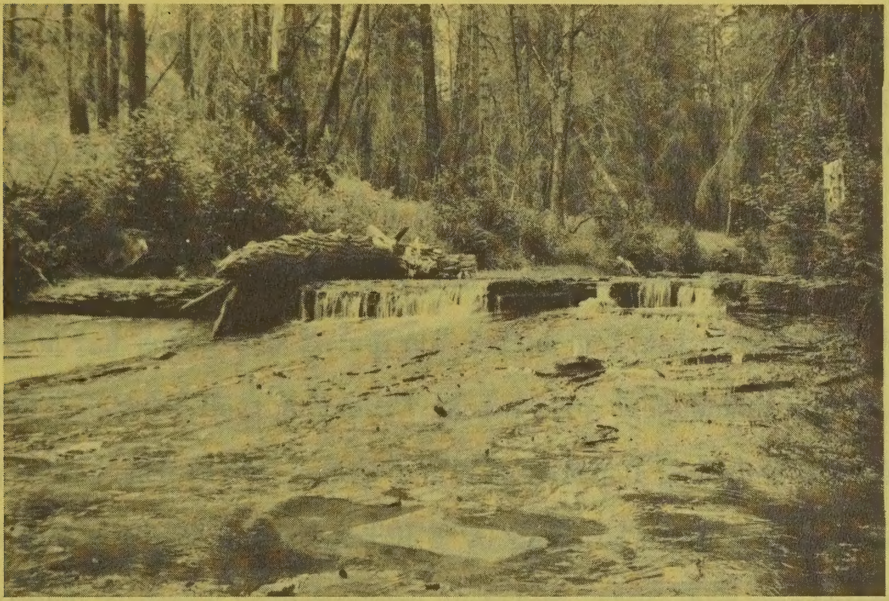
The disastrous Oxbow fire occurred mostly in the Smith River Basin of Oregon during 1966, and subsequent deleterious road building and logging destroyed much of the anadromous salmonid fish habitat in 50 miles of streams. The Bureau of Land Management decided to initiate a pilot fish habitat improvement and rehabilitation project. One stream which typified conditions in the Smith River basin was selected for fish habitat renewal. Successful management techniques developed in this project would then be applied to the entire basin over time. Towards this end, a technique was developed for the construction of rearing pools in a sandstone bedrock stream by dynamiting and excavating material. This paper presents the techniques and results of one promising management technique for increasing salmonid production in a specific stream habitat type.

STUDY AREA

The Vincent Creek basin (see Location Map) was selected as the pilot area because: (1) it had been partially burned in the Oxbow fire,

Lower Vincent Creek following the Oxbow Fire and salvage logging.

(2) it is an area of active logging, (3) its headwaters had been severely burned and salvage logged in 1951, and (4) the stream bed is dominated by sheets of solid sandstone bedrock in its lower reaches.



Vincent Creek dominated by sheets of solid sandstone

These characteristics typified most of the streams in the Oxbow Burn area.

The Vincent Creek Basin consists of approximately 19 square miles (9003 hectares) and is located in T. 20 S., and T. 21 S., R. 9 W., Will. Mer. Terrain in the area is generally very steep to extremely steep (60-90% slope). The soils in the drainage are shallow to moderately shallow. Generally, erosion hazard is severe to very severe with mass soil and rock movements being frequent. Vincent

Creek is approximately ten miles (16.9 kilometers) long, and varies in width from thirty feet (9.14 meters) to less than one meter. Stream gradient is approximately 1.5% slope. High flows often reach 1400 CFS in winter while summer flow drops to 0.5 CFS.

Vegetation of the slopes of the drainage consists of coniferous forest. Much of the area has been logged and subsequently reforested with Douglas fir. Streamside cover is dominated by mixed conifers, red alder and bigleaf maple. Recent logging activity along the creek has removed blocks of timber, leaving buffer strips of deciduous hardwoods and shrubs. The headwaters of Vincent Creek, burned in 1951, are densely vegetated with young Douglas fir and alder, while the lower portions of the drainage are dominated by a patchwork of varying age clear cuts with shrubbery and small conifers interspersed among a Douglas fir timber stand that is approximately 120 years old.

METHODS

The entire Vincent Creek basin was first surveyed to provide complete inventory and analysis of the fisheries resource as well as factors influencing general fish habitat. It was found that a significant amount of stream bed is dominated by sheets of solid sandstone bedrock. The riffle-pool ratio was determined to be 80/20% respectively. This ratio was considered less desirable than one approximating 50/50%. The bedrock riffles were generally less than three inches in depth. Several large natural pools were surveyed that provide excellent rearing area for all species of salmonids.

The creation of pools in the bedrock riffles to improve the riffle/pool ratio and thus increase salmonid rearing capacity was undertaken in the fall of 1972 on a pilot basis. The success of the test area led to creation of twelve more pools in 1974. Pool construction sites were located where natural scouring would keep them clean. The pools were created by blasting with dynamite followed by excavation with a bucket-equipped tractor.

The fish populations in the pool areas were sampled in June before and after construction. Control units were also sampled before and after the construction for comparative purposes. Fish populations were estimated by Peterson's mark-and-recovery method (Ricker, 1968) or the two-pass, removal technique of Seber and LeCren (1967). Further analysis of the data included comparisons of means using pooled variances and also treatment contrasts for equal and unequal numbers of observations.

POOL CONSTRUCTION

The technique developed for constructing the rearing pools is similar to that for quarry rock excavation. The holes were drilled on a grid pattern with a 5' x 5' spacing where the depth of hole governs the pool depth, Illustration I, Appendix II. Dynamite sticks were dropped into the holes until filled. Charges were wired to a central detonator line and ignited electrically.

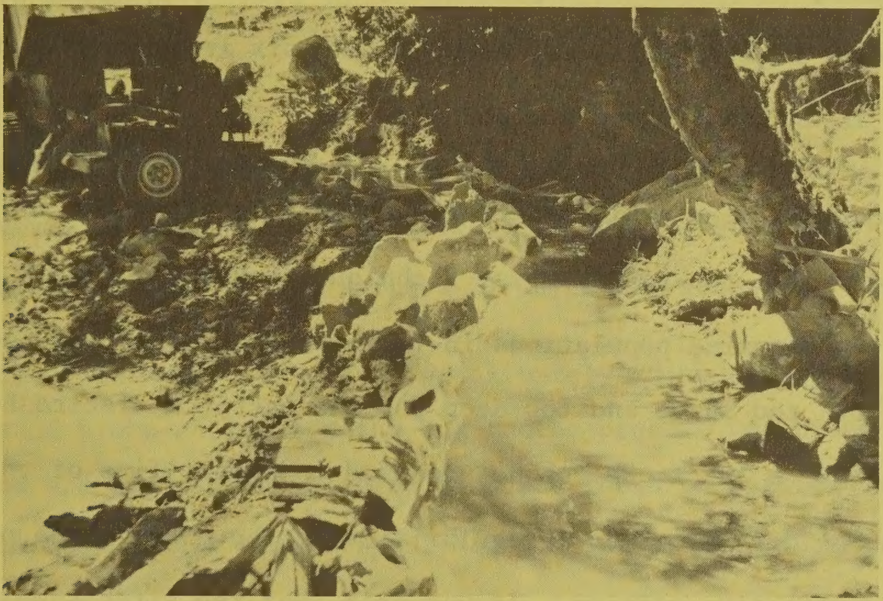
The charges were gauged to fracture the rock but not to the extent of pitching material out of the pool area. This worked quite well.

Vegetation in the immediate vicinity (20 feet of the blast) sustained minor damage but no change in canopy occurred. The leaves were coated with fine greyish sand particles which were washed away with the autumn rains.

Rock was removed and placed on flats adjacent to the stream. At some pool sites with limited gradient, selected large fragments were used as riprap to direct and constrict stream flow as it entered the pool area to increase the scouring effect. The immediate color of the broken rock was blue-grey in contrast to a yellowish-brown of weathered sandstone in and adjacent to the stream. After the first winter, the excavated material was almost indistinguishable from the surroundings. The visual impact and environmental aspects of the work were a major concern. Several tours composed of citizen advisory groups and public officials viewed the area the year after construction and expressed satisfaction with the visual impact.

Excavation of the rock was conducted using a crawler tractor equipped with a front-end bucket.

Stream flow in Vincent Creek was directed around the work site by building a channel of heavy gauge (10 mil.) polyurethane film. A 1,000 gpm pump was used to remove seepage water from the pool being excavated.



Plastic by-pass channel with pool de-watering pump in the background.

The water was pumped into the forest litter to prevent contamination of Vincent Creek by fine particles produced by drilling, blasting, and track movement. Small particles suspend readily in the water column and can create turbidity problems for some distance downstream if allowed to enter the stream course. The most effective layout for efficient work and maximum water quality protection is shown in Illustration 2, Appendix II.

POPULATION SAMPLING

Sites on riffles were selected for pool construction in the spring of 1972. Populations at each site were sampled using a backpack electroshocker. The sites were cordoned off with seines, and the areas were repeatedly fished until depleted. A total of 18 units were selected. Of these, twelve pools were created, and six areas were left as controls in an undisturbed state.

The controls were again electrofished in 1974 after the pools had been created. The two-pass removal technique (Seber and LeCren 1967) was used to determine populations in these areas. Since the pool areas were both too large and too deep for the backpack electroshocker to be effective, a 10' x 50' seine was used to sample five of the pools. Large boulders or other irregularities in the other seven pools precluded effective seining. It was felt that the sites sampled were representative of all of those created. The Peterson mark-and-recovery procedure (Ricker, 1968) was used in pool population estimation.

Fish population analysis for the four sets of data, (pre-construction pools, pre-construction control riffles, post-construction pools, and post-construction control riffles) entailed a total of twenty-four comparisons. Length comparisons utilized all fish collected on the respective dates and locations. The comparisons of population abundance and length represented by the level of significance are shown in Appendix I, Tables 1 and 2.

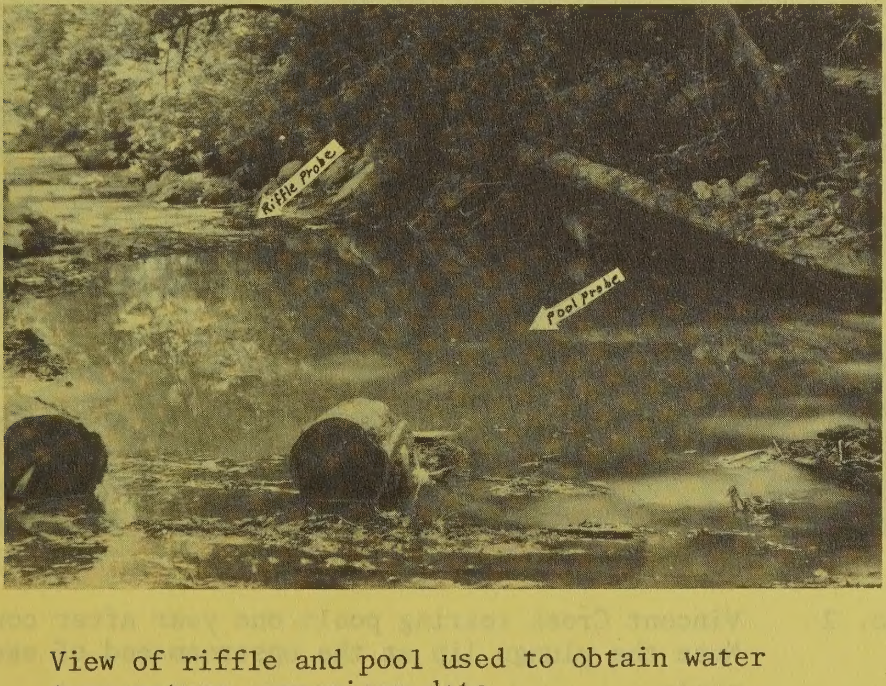
POPULATION COMPARISON

Mean comparisons were calculated by using a pooled variance. Contrasts of population were conducted by using the F-tests. The four species of fish included in these comparisons and contrasts were juvenile (age 0) steelhead trout, juvenile age 0 coho salmon, blackside dace, and redside shiner. Formulas used for calculation of comparisons and contrasts are listed in Appendix I, page 21.

TEMPERATURE

The temperatures in western Oregon streams are often critical to production and survival of salmonids. The effects of pool construction on water temperatures were monitored by two Partlow 31-day chart recording thermographs.

The thermographs were installed approximately 20 meters apart with about 6 meters of probe cable from the box to the probe. One probe was concealed from view and sunlight by placing it under rocks on a riffle approximately 70-150 mm deep at the head of pool No. 3. The other probe was located in the bottom of pool No. 3 at a depth of 1.5 m.



View of riffle and pool used to obtain water temperature comparison data.

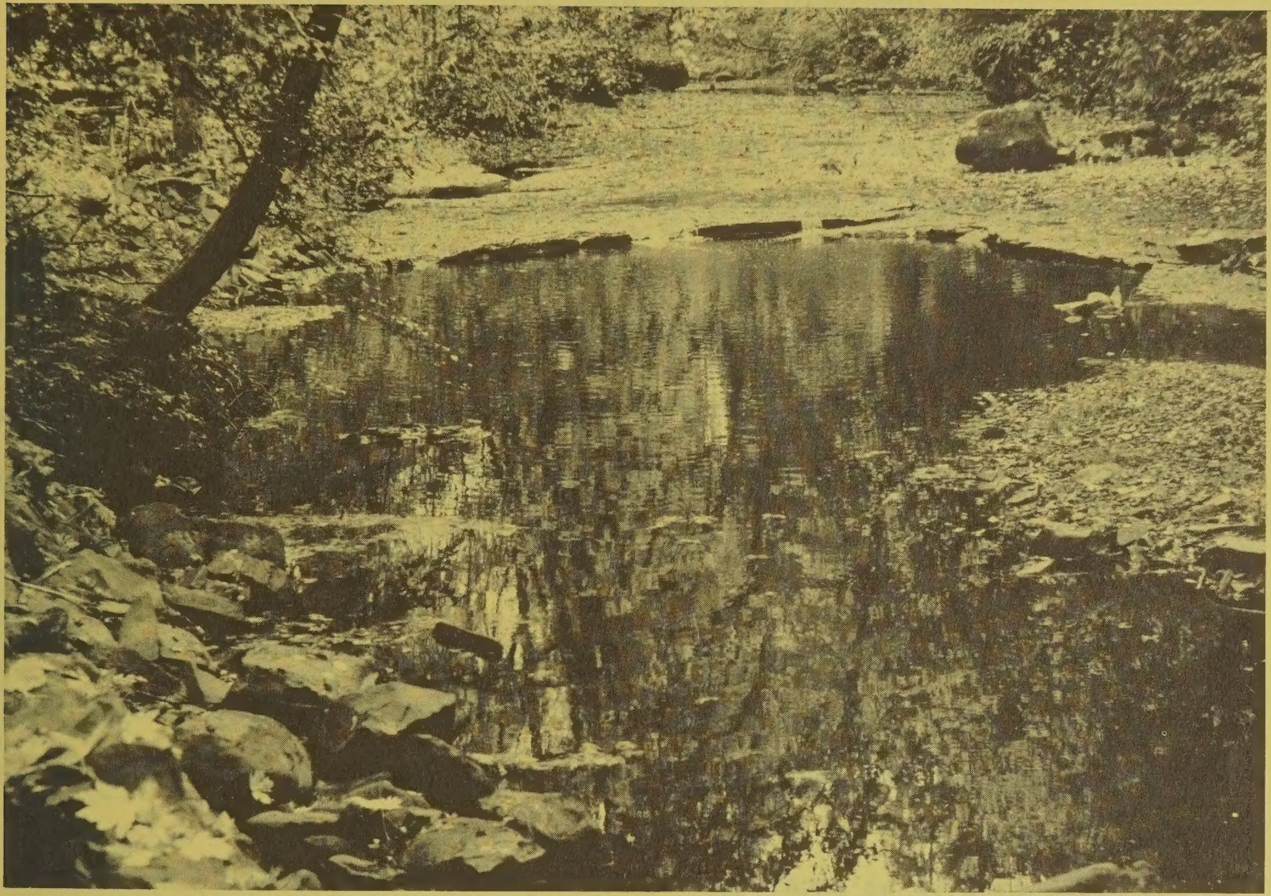
The chart recorders were calibrated to within ½ of 1°F of each other. They operated continuously from June 18 through September 31, when temperature dropped and water flow increased. A third recorder was located on a riffle area 1.5 miles downstream near the mouth of Vincent Creek (see Illustrations 3 and 4, Appendix II).

RESULTS AND DISCUSSION

POOL CONSTRUCTION

The construction phase of the project was successful. The pools were built according to plan and profile. The contract required only minor alteration which caused no delay in the work.

Pool No. 2 Vincent Creek rearing pools one year after construction. Note the plunge lip at the upstream end of each of these pools.



Pool No. 7

Freshets during the first winter filled the pools with bed load to a depth of 3-5 feet. This depth remained constant with all additional materials being flushed out. Each pool has exhibited a different hydrology due to configuration. These individual pool characteristics have influenced pool filling and bank deposition. The analysis of these hydrologic patterns set up by pool configuration leads to a conclusion that sites can be selected with confidence that desired results will be produced.

The analysis of pool sites during and following construction indicates that specific criteria should be adhered to for best results. Recommended criteria for site selection and construction are as follows:

1. Sites should be selected that have a plunge (small waterfall) or constriction at the head of a proposed pool. This will act to scour the pool clean during annual freshets.

2. The area above the pool site should be stable with only light bedload material. No area should be selected that has large rock or boulders 1-5 feet in diameter that will be moved into the site by freshets.

3. Pool sites should be located for easy equipment access from roads to streams, and they should be close enough to eliminate major transport of equipment on lowboy trucks which increases costs.

4. The area to be excavated should be wide enough to allow a bypass channel on one side and an equipment working area on the other side.

5. The entire excavation area should be tightly bermed off with some type of material that will not erode into the stream and cause turbidity problems.

6. All water that enters the excavation must be pumped to an area where it can filter into the ground and not run directly into the stream.

7. All pools should be located far enough away from each other to prevent two pools from merging through fracturing of rock between the sites.

8. The excavated material removed will be rather extensive and ample area should be made available for its placement.

9. Stream flow is a major consideration when developing a project of this nature. It is critical that the water be diverted away from the work site. The volume of water during lowest annual flows should be accurately measured several years prior to beginning construction. If the volume of water to be contended with by the operator is known, it will enable him to obtain proper sized pumps and diking material. It is very likely that the contract bid will be lower if the bidder has accurate data and does not feel a need to add more to the price to cover risk.

POPULATION STATUS

Pool construction on Vincent Creek, in general, has resulted in some species of fish increasing in size and number or both. The limited data available provides no correlation for other species at this time. Tables 1 and 2, page 14,show these changes in length and number by species. The comparisons of fish populations and length with respective differences represented by the level of signifance is listed in Appendix I, Tables 1 and 2.

It appears that 1974 was generally a very favorable year for fish production in that all populations were higher than in 1972. This may have masked some of the population differences between the controls and pools.

The sampling conducted in 1974 was done in replicate. First an early sample in June, 1974, was conducted to correspond with the previous

June, 1972, pre-construction data. The second sampling was conducted in late August, 1974, during the annual low water pinch period. This second sample showed some noticeable changes from the June data.

Table 1: Weighted mean lengths of fish sampled from the respective areas and dates of sampling.

MEAN LENGTH in MM

		Pre-construction	Post-construction	
		June, 1972	June, 1974	August, 1974
Cutthroat Trout	Pool	125.0	153.0	201.0
	Control	124.0	111.0	105.0
Steelhead Age 0	Pool	45.5	53.3	64.9
	Control	47.5	58.5	63.9
Coho Salmon	Pool	58.7	76.3	81.0
	Control	64.7	72.8	*
Blackside Dace	Pool	69.9	52.4	63.2
	Control	74.0	68.2	63.9

* only one coho captured on control units.

Table 2:

MEAN NUMBER of FISH SAMPLED
FROM RESPECTIVE AREAS and DATES

		Pre-construction	Post-construction	
		June, 1972	June, 1974	Aug., 1974
Cutthroat Trout	Pool	0.75	2.8	1.8
	Control	1.75	0.4	1.0
Steelhead Age 0	Pool	7.7	83.0	51.4
	Control	8.9	49.4	64.3
Coho Salmon	Pool	3.0	28.7	31.4
	Control	3.4	5.6	0.3
Blackside Dace	Pool	29.7	2.0	22.0
	Control	8.4	37.4	38.0

Juvenile Coho Salmon (Oncorhynchus kisutch)

The populations of juvenile coho salmon showed the most noticeable salmonid response to construction of pools. The coho populations in the control units remained at a very low level during all sampling. The pool population levels increased by nearly 10-fold. Early 1974 sampling indicated that the coho in the pools were significantly larger than those in the control units. Only one coho was captured in the control units during late August, 1974, which prevented any meaningful length comparisons.

Cutthroat Trout (Salmo clarki)

Cutthroat trout were found only in limited numbers during the study. The pre-construction sampling indicated less than two fish per unit. The post-construction data also showed less than two fish per pool or control unit.

The significant difference between pools and controls was in the length of fish. The fish in the control units remained approximately the same while pool unit fish increased by about 80 millimeters. The larger fish in the pool units were of the size deemed legally catchable in coastal streams. This may indicate a possible means for providing stream angling where very little previously existed.

It should be noted that sampling technique utilized (seining) in the pools was relatively inefficient for catching large trout. This may have resulted in underestimates of abundance.

Juvenile Steelhead Trout (*Salmo gairdneri*)

The size and abundance of age 0 juvenile steelhead trout were not changed significantly by the project. The most notable change occurred in June, 1974, when pool populations were significantly higher than those in controls. These differences were not significant two months later in August of 1974.

There are two possible explanations for this difference. The first may be sampling error. If an error occurred, it was probably in the pools which were difficult to sample. This would lead to an underestimate of age0 steelhead in the pools.

The second explanation may be an increase in predation in the pools by larger trout which reduced the juvenile steelhead populations by late summer.

Blackside Dace (*Rhinichthys osculus nubilus*)

A comparison of blackside dace populations shows a large fluctuation. Populations in the pools were reduced during June of 1974, but rebounded by August of 1974. Control unit populations shows no significant changes.

The length of fish in the pools was also reduced in June, 1974, (compared to controls). However, the August samples showed control and pool fish to be the same length.

No conclusion can be drawn from this data. Specific life history data for blackside dace in this region is lacking. This deficiency in life history knowledge makes it difficult to determine whether length and abundance fluctuations are tied to the habitat change or some natural phenomena inherent to the blackside dace, such as migration, growth, or hatching.

Redside Shiner (Richardsonius balteatus)

Comprehensive analysis of the redside shiner populations was hampered by the sporadic occurrence and generally low population levels of this species. In general, there were no significant differences noted in any of the comparisons.

There was also insufficient data to conduct an analysis of the population structure of redside shiner occupying either control riffles or pool areas.

TEMPERATURE

Water temperatures on the riffle and in the pool remained the same until stream flows began to decrease and air temperatures increased.

By late July water temperatures in the pool and riffles began to exhibit a noticeable difference. The temperatures in the pool were 1-4°F lower than those on the riffle and the peak temperature period in the pool was shorter. The peak temperature (over $72^{\circ}F$) on the riffle above the pool lasted approximately 12 hours (noon to midnight) while the pool peak lasted 1-2 hours (about 12 midnight). The temperatures recorded 1.5 mile downstream on the riffle corresponded closely to those recorded upstream on the riffles as shown in Illustrations 3 and 4, Appendix II.

SUMMARY

Pool construction in Vincent Creek has produced tangible results that appear useful in the art of habitat manipulation. The technique of constructing pools in solid sandstone bedrock produced bodies of water that are reasonably permanent and require low maintenance.

Comparison of fish populations between controls and pools indicates a significant increase in coho salmon at the pool sites following construction. The present data are limited and insufficient to make any positive population projections for blackside dace, cutthroat trout, redside shiner, and age 0 steelhead trout.

The pools influence the diurnal water temperature range by lowering peak temperature and shortening peak period.

The length of coho salmon and cutthroat trout in the pools was increased whereas pool-reared age 0 steelhead and blackside dace showed fluctuations but no overall change. Although it can be shown that the length of some species of pool-reared salmonids was influenced by this new habitat, it is not known whether this will significantly influence their survival.

Managers seeking to increase pool area in streams may be able to use this construction technique for species other than coho salmon. There is no information at this time to indicate the number of catchable salmonids these pools will produce. Any large scale project of this nature should be preceded by an intensive research study to determine the actual return of fish to fisherman and the cost-benefit ratios.

LITERATURE CITED

Anderson, J.W. 1973. Evaluation of excavated fish rearing pool in Vincent Creek. Technical Note No. 6763, U.S. Bureau of Land Management. 5p.

Ricker, W.E. 1968. Handbook of Computations for Biological Statistics of Fish Populations. Bulletin No. 119, Fish. Res. Bd. Canada. 300p.

Seber, G.A.F. and LeCren, E.P. 1967. Estimating Population Parameters from Catches Large Relative to the Population, Journal of Animal Ecology. 36:631-643.

APPENDIX I

Table 1: Comparisons of fish populations with the respective differences represented by the level of significance.

	Pool Post-construction		Control Riffle Pre-Construction		Control Riffle Post-construction	
Pool Pre-construction	Dace	NS	Dace	0.5	Dace	NS
	Shiner	NS	Shiner	NS	Shiner	NS
	Coho	.01	Coho	NS	Coho	NS
	Trout	.01	Trout	NS	Trout	.05
Pool Post-construction			Dace	NS	Dace	NS
			Shiner	NS	Shiner	NS
			Coho	.01	Coho	.01
			Trout	.01	Trout	NS
Control Riffle Pre-construction					Dace	.05
					Shiner	NS
					Coho	NS
					Trout	.05

Table 2 : Comparisons of fish lengths with the respective differences represented by the level of significants

	Pool Post-construction3/		Control Riffle Pre-construction		Control Riffle Post-construction	
Pool Pre-construction	Dace	NS	Dace	.10	Dace	NS
	Shiner	*	Shiner	*	Shiner	*
	Coho	.01	Coho	.10	Coho	.01
	Steelhead1/	NS	Steelhead	NS	Steelhead	.01
Pool Post-construction3/			Dace	.01	Dace	.01
			Shiner	*	Shiner	*
			Coho	.012/	Coho	.114
			Steelhead	.01	Steelhead	NS
Control Riffle Pre-construction					Dace	.01
					Shiner	*
					Coho	.01
					Steelhead	.01

* No data for comparisons

1/ "Steelhead" refers to age 0 steelhead only

2/ Coho comparison only compares post-construction pools sampled in June, 1974, with June, 1972.

3/ Post-construction utilizes August, 1974, and June, 1974, samples.

POPULATION COMPARISON

Comparisons and contrasts of population and length data were conducted for four species of fish. These include: juvenile (age 0) steelhead trout, juvenile (age 0) coho salmon, blackside dace and redside shiner.

In the calculation of treatment contrasts, the analysis of variance enables one to evaluate the effect of the treatments with the internal variation found within each treatment as well as the actual testing of the null hypothesis. The F-test for contrasts is defined as:

$$F = \frac{\text{Sum Squares Contrast}}{\text{Mean Square Error}}$$

Mean comparisons were calculated using a pooled variance. That is,

$$S_2 = \frac{SS_1 + SS_2}{n_1 + n_2 - 2}$$

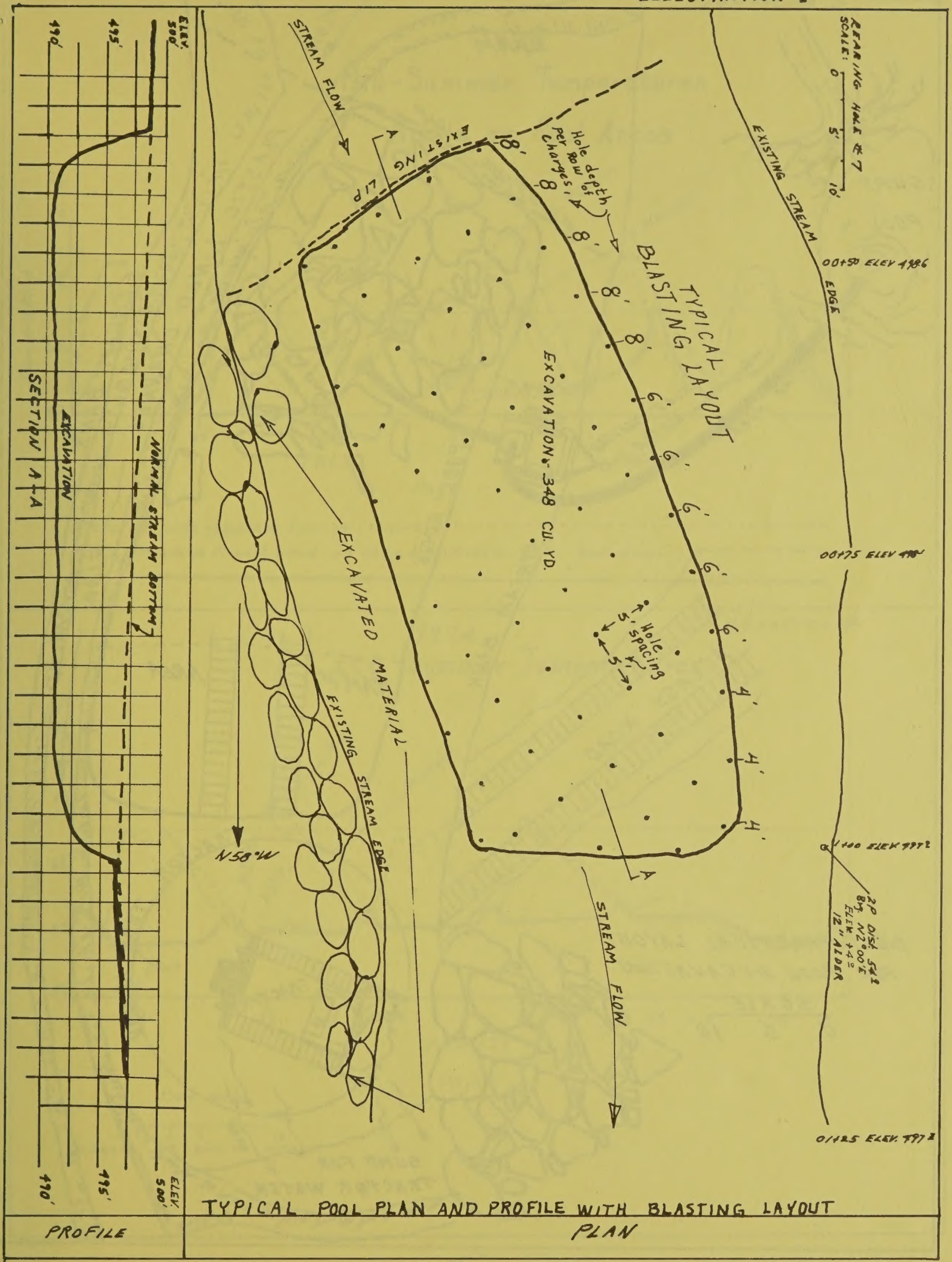
where SS_1 is the sum of squares of the first population and SS_2 is the sum of squares of the second population. The null hypothesis was tested by the two-tailed t-test where:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{S\bar{x}_1 - \bar{x}_2}$$

with $n_1 + n_2 - 2$ degrees of freedom.

APPENDIX II

ILLUSTRATION 1



TYPICAL POOL PLAN AND PROFILE WITH BLASTING LAYOUT

ILLUSTRATION 2

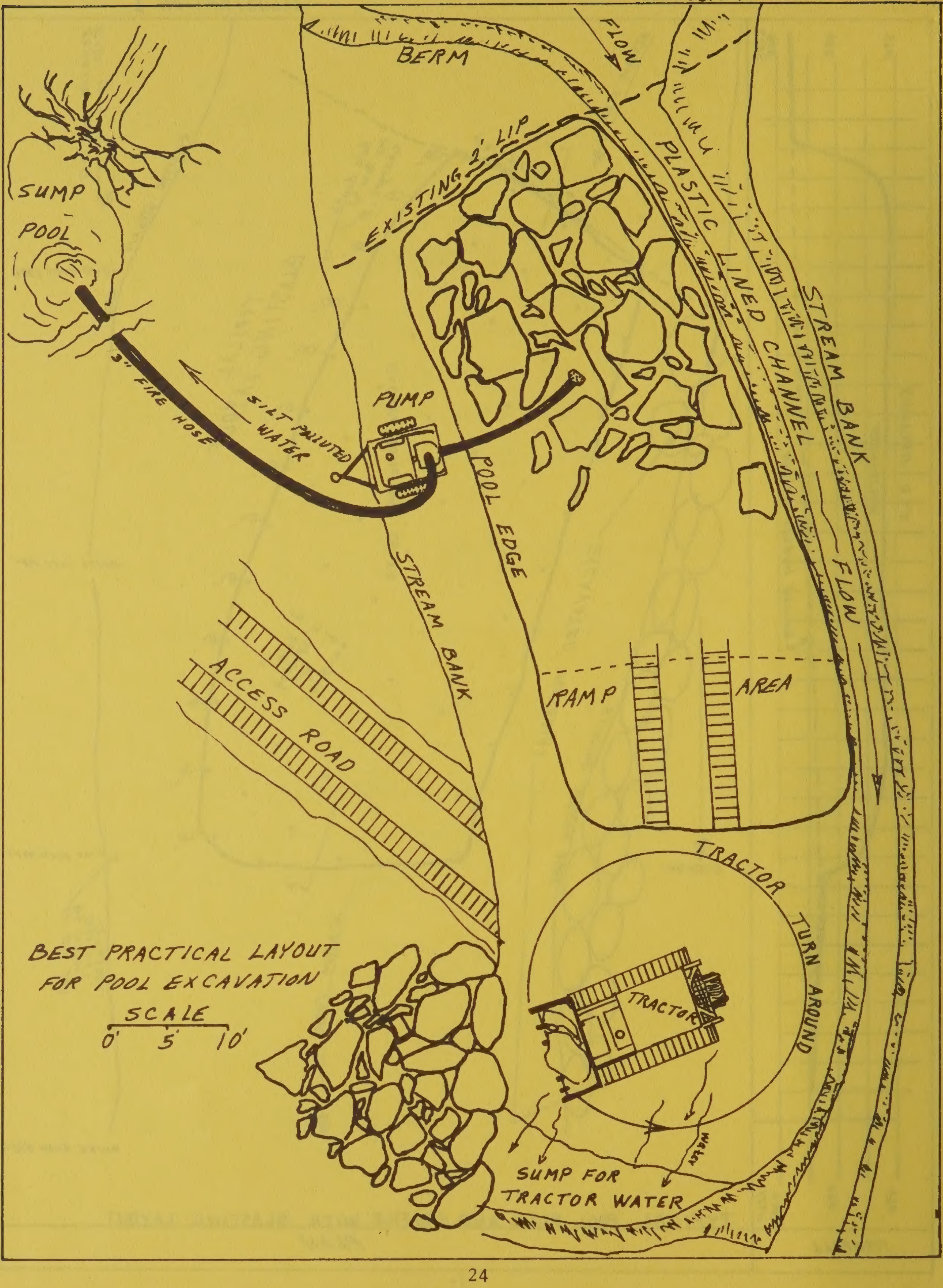

BEST PRACTICAL LAYOUT FOR POOL EXCAVATION

Illustration 3

1974
Mid-Summer Temperatures
Riffle vs. Pool Areas

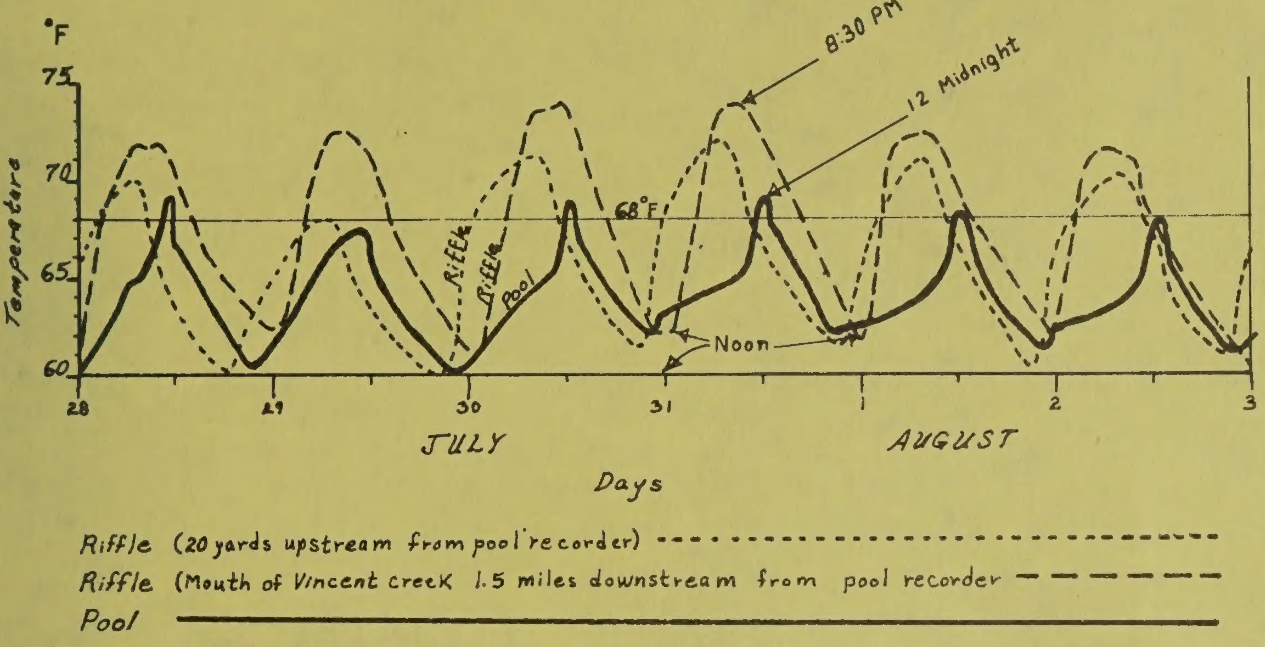
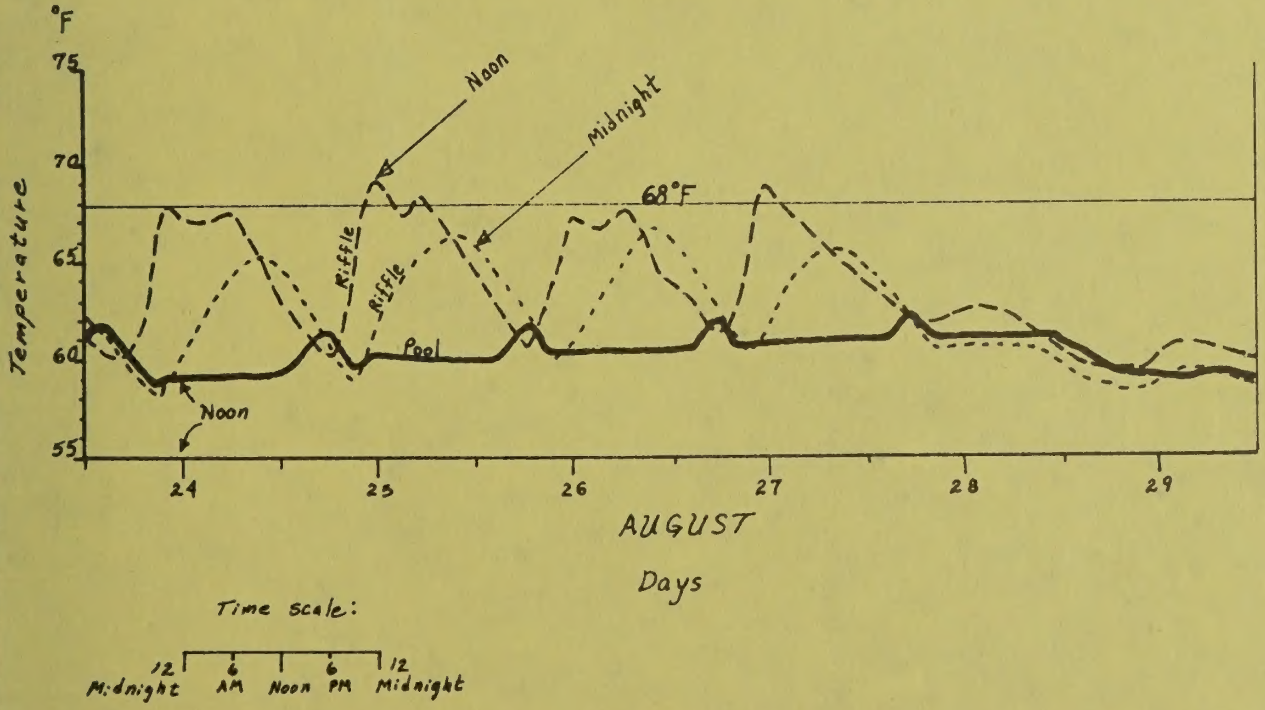


Illustration 4

1974
Late Summer Temperatures



BLM Library
Denver Federal Center
Bldg 50, OC-521
P.O. Box 25047
Denver CO 80225